Modelling Best Execution Systems with Market Modelling Language

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Abstract

The worldwide integration of the financial markets leads to increasing competition between financial institutions. Thus, best execution systems and bank internal systems have been initiated in order to improve the competitive ability and customer services. Not all of these systems have been successful. Therefore, tools are required to support the design and testing of such systems in order to avoid pricey flops.

The generic electronic trading platform meet2trade provides a set of tools that facilitate the design of electronic markets. In this paper, we examine MetaMarkets and market modelling language MML in order to demonstrate their feasibility in modelling real existing best execution systems Xetra Best of Deutsche Boerse AG and BestEx service of Nasdaq Germany and bank internal system ICOM of Commerzbank AG.

Keywords: electronic markets, best execution, market modelling, market modelling language, market engineering
1. Introduction

In recent years, the organization of stock exchange trading has been subject to major changes. The trend for major banks to process customer orders internally has increased. The bank acts as *market maker* and processes the customers’ buy orders according to the asking price, selling orders according to the bid price.

Following this trend, especially in Germany, major banks tried to set up an application based on this principle. Therefore, bank internal systems have been initiated in order to provide such services to their customers. Usually, these proprietary services are concatenated as upstream components to trading systems. On the other hand, traditional stock market providers, like Deutsche Boerse AG, run open systems such as *Xetra BEST*, providing similar services. Not all of these systems have been successful. Since the market modelling task is challenging and the success depends on multiple factors, it is worth investigating whether the modelling task can be supported [10].

Electronic markets differ from traditional markets in that rules determining the market outcome have to be designed. The impact of market design is shown in a number of studies on very diverse markets, from stock exchanges to fish and electricity markets (c.f. [15]). The impact of the market design is difficult to predict and errors in the design can be extremely costly [6]. Thus, tools and methodologies are required to support the market designer in setting up a market design in the required way. Such tools not only support the design of electronic markets but also the design task through simulations and experiments which provide an indication of the impact of the design on the results. Simulations and experiments can be used to prevent costly mistakes. Such tools and methodologies focus on the market engineering research field.

Traditional concepts of market modelling are not advanced enough to fulfill all needs of market participants within one trading platform (c.f. [17]). Thus, new concepts have been developed to fill the gap between feasible and desired properties of market models. The concept of MetaMarkets [8] was originally created as an implementation concept for cascading dynamic market models (CDMMs) [13] within the meet2trade generic trading platform. A MetaMarket is defined as a set of markets and rules representing relations between markets and their environment. Therefore, it provides a concept for managing CDMMs and, in particular, for coordinating multiple market models through rules.

CDMMs can be examined from two perspectives. Firstly, the order’s perspective allows the market participant to define within the order sequences of markets that the order has to pass through until it is traded. Secondly, the market’s perspective allows the market designer to define a market structure that is the parameters of the market mechanism and the trading rules as well as a combination of multiple, parallel, or sequential combined market models within one trading platform. Since this paper is about modelling of best execution systems, it focuses on the second case.

Within this work, some real existing systems are assessed on their capability of being modelled by the concept of MetaMarkets. If this is the case, they lend themselves to be modelled with the Market Modelling Language (*MML*) that will be introduced in Section 2. The focus of this paper is set on the modelling of Xetra BEST [2] with the aid of MML and MetaMarkets. This is done in Section 3. The additional MML formulations for the Nasdaq Deutschland system can be done as an adaptation to the MML modelling of Xetra BEST and are discussed in Section 4. Section 5 presents an adaption of an off exchange trading system ICOM operated by Commerzbank AG for their private customers. Finally, Section 6 concludes this work.

2. MML as a market modelling tool

This Section briefly discusses few important properties of MML in order to build necessary background for the subsequent discussion on modelling of best execution with MML.

2.1. Theoretical fundamentals

As aforementioned, a market model is a set of rules that determine trading conditions. According to [17] the most fundamental element to define an exchange is its market model. McAffee and McMillan define an auction as "a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants" [11]. Auctions are resource allocation mechanisms which enable the trading and which can be designed and described by rules over language, adjustment process, choice, and transfer. In this context, trading describes the interaction and coordination between buyers and sellers to exchange information, goods, ser-
Commonly, two kinds of auction mechanisms are used for stock markets: call auction (CA) and continuous double auction (DA)\(^2\). In CAs, the price finding mechanism is triggered by the time and orders are batched together for simultaneous execution. In DAs, the price determination is triggered by each incoming buy or sell order. Trade can be made when they meet in price ([4], [17]). In modern stock exchanges, these auction types are commonly united in a hybrid structure in order to receive more liquidity in markets (c.f. [17]).

Firstly, computer-supported auction definition, specification, and subsequent automatic execution needs high knowledge about requirements that need to be considered to set up an auction, secondly, a systematic use of rigorous underlaying theory considering the concrete implementation of these requirements, and thirdly, a systematic structured process that divides the design process into phases and recommends methods to solve the tasks within the single design phases ([14], [19]).

Kalagnanam and Parkes have proposed an auction classification framework with six categories that focuses the requirements for auction set up [5] considering:

1. Resources over which the negotiation is to be conducted,
2. Market structure defining the negotiation mechanism between buyers and sellers,
3. Preference structure defining the agent’s utility for different outcomes,
4. Bid structure defining how flexible agents can express their resource requirements,
5. Winner determination, and
6. Information feedback defining which information form the current auction is given, when the information is provided, and who gets it.

Based on the negotiation process execution task presented in [16] and on its further refinement in [18], the authors of [9] suggest a generic domain-independent trading platform that provides various auction types. They provide requirements for such a platform and introduce the basic transaction process within the generic platform that fulfills given requirements. Concerning these requirements, they present central characteristics for the genericity: Firstly, "the order structure is constructed in a way that it serves various applications irrespectively of the current domain". Secondly, the "transaction process has to be defined and structured as a reusable process" [9] what means that the basic process structure can be used in all auctions. Based on that, [7] suggests to build up the generic process concerning the offer life cycle within a generic trading platform. The basic idea here is that from the order point of view, the generic process means that it is passed through identical phases of execution whereas the execution within the single phases depends on the current auction type that can be configured.

Putting these ideas together leads to the MML that supports the six categories for auction set up given in [5] and enables the definition of generic order structure and configuration of the generic transaction process based on the offer life cycle. Thus, MML provides elements to define procedures used for the price discovery and for the interaction of participants with the trading system. In addition, it consists of elements for the specification of allowed market participants, elements for information feedback, and for the matching mechanism.

### 2.2. Implementation of the MML

MML is a XML-based modelling language. The modelling elements of MML are subdivided into two distinct groups. Hence, MML consists of two main blocks used to describe a market model: MarketModel and Meta-Market (c.f. Figure 1).

![Figure 1. Two main blocks of MML](image)

The MarketModel-block contains elements to describe a single auction mechanism. These elements describe, for instance, which kind of products are traded, which participants are allowed to take part in the trading, which information participants get from the current auction, and how the price in the current auction is determined and the fees of the current market model.

As aforementioned, a MetaMarket consists of market models and rules representing relations between markets and their environment. Thus, the MetaMarket-block of MML consists of elements to describe these
components. Note that both, markets and rules, are considered as components which are used within a MetaMarket to build complex market structures - like best execution systems where multiple different market models are unified into one market model.

In the MML the $\textit{MetaMarket}$-block is further divided into two subareas: $\textit{MarketAttributes}$ and $\textit{MetaMarketAttributes}$ (c.f. Figure 2). Rules for starting and stopping individual market models are defined in the subarea $\textit{MarketAttributes}$. Market starting rules are based on exogenous events like time (market model is started at a specific point of time) or some other event (like starting or stopping) of another market. Market stopping rules are defined by exogenous or endogenous events. Exogenous events are the same as in the case of starting rules. An endogenous event is, for example, the circuit breaker, time of inactivity within the current market or number of offers submitted into it. Within the MetaMarket, market models are identified by the attribute "MarketName". The components are shown in Figure 3. The $\textit{MetaMarket}$-block contains elements to describe the MetaMarket.

Henceforth, we list the most important properties characterizing Xetra BEST and the modeling with MML.

### 3.1. Definition of Xetra BEST Participants

For the implementation of advanced trading systems, hybrid forms of organization are used at major stock exchanges, like Xetra [3], where classic trading platforms coexist with the services for private investors’ order processing to a BEST price at the market (BEST Execution System). It makes the stock exchange more attractive and more competitive. For this purpose, the Deutsche Boerse AG has added to the classic trading platform Xetra such an service named Xetra BEST, which is built on the existing platform and is tightly related to its structure. In-coming orders are scrutinized on their fulfillment of admittance to this service. If not, they are handled over to Xetra and processed there.

Consequently, from a structural point of view, we have an additional service attached to the classic trading platform Xetra, as Xetra is able to work on its own without Xetra BEST, but not the other way round. All of Xetra BEST attributes are Xetra-specific with additional conditions for a processing on Xetra BEST: The participants, the handled orders (market orders, limit orders), the trading time (only during Xetra continuous trading time) and especially the execution price (based on ‘best bid/best ask’ of the central order book) strongly depends on Xetra. An independent processing of Xetra BEST could never be possible without Xetra, but not vice versa. Thus, it is not persuasive to view Xetra BEST as a market model on its own, so, we model Xetra BEST as an additional extra service of Xetra. A precise investigation and implementation of this service serves as an enhancement of the MetaMarket concept in order to give guidelines for the development and configuration of these systems.

New parameters must be defined now in MML to enable the modelling of Xetra BEST as an extra service of the MetaMarket Xetra (the mapping of Xetra on the MetaMarket model is not part of this work). In order to model best execution as an additional service, the BestExecution sector is defined in MetaMarkets. The definitions for best Quote and the admitted users are given in the following XML draft.

```
<MetaMarket>
  <BestExecution>...</BestExecution>
</MetaMarket>
```

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### 3. Modelling of Xetra BEST with MML

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### 3.1. Definition of Xetra BEST Participants

In the following, the Xetra BEST market participants are defined in sector AllowedUsers, a part of BestExecution.

**BEST executor**: Xetra market participant who provides best execution to own or other members’ (flow provider) customers. An important component of Xetra BEST is a liquidity providing obligation for the BEST Executor. The BEST executor has to provide or assure the providing of quotes in these equities in the Xetra order book (“order book quotes”) [3].

Each BEST executor is identified by the parameter ExecutorID, which has a string value. His function for a best execution and the liquidity providing obliga-
3.3. Parameters of BEST Quote

Xetra BEST quotes are private quotes that are provided on the basis of quote parameters by BEST Executor in order to provide price improvement relative to an execution within the order book. These quotes are not shown in the order book [2].

Relative limit (mandatory) The relative limit is set in order to have a moving BEST quote which depends on the current best bid or best ask of the reference market or the volume weighted average (VWA) for the size of the Xetra BEST order in the order book. This relative limit (+/- one tick if another tick size applies) always refers to the actual situation in the Xetra order book and minimizes communication load between the member’s front end and the Xetra back end.

Boundary (optional) In order to protect BEST Executors from adverse price movements (due to the moving quotes depending on the current order book situation), a boundary that serves as an upper bound for the bid leg of the quote (a lower bound for the ask leg of the quote) can be specified.

Size (mandatory) A predefined size has to be assigned to the BEST quote by the BEST executor. This is the maximum executable size for one BEST order which is subject to execution against the BEST quote at the specified quote limit.

3.2. Xetra BEST order types

Finally, the allowed order types have to be defined. If one market participant allowed to take part in this best execution model submits another kind of order, it will automatically be forwarded into the standard trading system - in this case Xetra.

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Size (mandatory) A predefined size has to be assigned to the BEST quote by the BEST executor. This is the maximum executable size for one BEST order which is subject to execution against the BEST quote at the specified quote limit.

Reserve size (mandatory) In order to be able to specify a quote once for a whole set of Xetra BEST executions, BEST Executors are provided a reserve size parameter. It is important to point out that incoming orders are always executed against the quote size (see c) only and do not immediately match the reserve size and though might be forwarded of the order book.

These parameters are now defined in MML under BestQuote, which is a component of the section BestExecution in MetaMarkets. They can be entered separately for the bid and the ask side in a given instrument.

- The parameter RelativeLimit shows the relative limit and has a double value.
- The parameter Boundary describes the boundary and has a double value, too.
- The parameter Size refers to the maximum BEST order size. It has an integer value.
- The parameter ReserveSize defines the reserve size and has an integer value, too.

3.2. Xetra BEST order types

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- The parameter RelativeLimit shows the relative limit and has a double value.
- The parameter Boundary describes the boundary and has a double value, too.
- The parameter Size refers to the maximum BEST order size. It has an integer value.
- The parameter ReserveSize defines the reserve size and has an integer value, too.
The parameter ProductCategoryID shows the identification of the stock which is performed at the BEST execution.

```xml
<BestQuote>
  <BidSide>
    <RelativeLimit>
      <TickSize>monetaryUnit</TickSize>
      <char/> <!-- In "+" form -->
    </RelativeLimit>
    <Boundary>...</Boundary>
    <Size>n</Size>
    <ReserveSize>m</ReserveSize>
  </BidSide>
  <AskSide>
    <RelativeLimit>
      <TickSize>monetaryUnit</TickSize>
      <char/> <!-- In "-" form -->
    </RelativeLimit>
    <Boundary>...</Boundary>
    <Size>n</Size>
    <ReserveSize>m</ReserveSize>
  </AskSide>
</BestQuote>
```

3.4. Reference markets of Xetra BEST

Finally, the reference markets have to be defined. Note that multiple reference markets can be used in practice. Thus, in MML multiple markets can be defined as a reference market. In the case of Xetra BEST, the only entrance in the MarketNames-list is "Xetra".

```xml
<BestExecution>
  <ReferenceMarkets>
    <MarketNames>[name list]</MarketNames>
  </ReferenceMarkets>
</BestExecution>
```

4. Modelling of BestEx service of Nasdaq Germany in MML

Nasdaq Germany does not exist any more. Anyway, the modelling of BestEx of Nasdaq Gemany is presented here in order to demonstrate the flexibility of MML in modelling best execution systems.

From a structural point of view, Nasdaq Germany was similar to the Xetra system together with Xetra BEST. The best execution system named BestEx coordinated the trading of the retail orders possible between Market Maker and Order Flow Provider. The Market Makers (equivalent BEST Executors in Xetra BEST) were able to provide their quotes for a best execution and liquidity orders in the order book. The Order Flow Provider (equivalent Flow Providers in Xetra BEST) assured an active relation to a Market Maker for the current trading day and sent his retail orders to BestEx to this Market Maker. The reference market used for the best Execution (Xetra) was determined and announced by Nasdaq Germany. The price for the best execution was the best price of the order book and the reference price of the reference market [12].

In the following, we perform the modelling of the most important properties characterizing Nasdaq Germany with the remaining parameters which are already defined in Section 3 for Xetra BEST. It is important to find out whether all of these parameters are able to define such best execution systems.

4.1. Definition of BestEx market participants

**Market Maker**: The functions of the Market Maker in the Nasdaq Germany were similar to those of the Market Maker in the Xetra BEST. They are defined now in MML with the parameters for BestExecutor in sector BestExecution.

```xml
BestExecutor.BestExecutorID = [MarketMakerID]
BestExecutor.BestQuoteProvide = true
BestExecutor.OrderBookQuote = true
```

**Order Flow Provider**: The functions of the Order Flow Provider in the Nasdaq Germany were similar to those of the Flow Provider in Xetra BEST. The identification of the Order Flow Provider is defined with the parameter FlowProviderID (FPID).

At the beginning of the trading day, each Order Flow Provider had to define his current relation to a Market Maker who is identified by the parameter BestExecutorID.

New parameter StatusActive is now defined for describing the status between Order Flow Provider and Market Maker which had to be displayed in Nasdaq Germany. This parameter has a Boolean value with 'true' for an active and 'false' for a not active relation.

```xml
<FlowProvider>
  <FlowProviderID>[FPID]</FlowProviderID>
  <toBestExecutor>
    <BestExecutorID>exId</BestExecutorID>
    <StatusActive>[boolean]</StatusActive>
  </toBestExecutor>
</FlowProvider>
```
4.2. Allowed order types of BestEx

Nasdaq Germany provided three types of orders: market order (MO), marketable limit order (MLO), and protected market order (PMO). For the definition of these order types MML contains parameter `AllowedOrderTypes` within the sector `BestExecution`.

\[ \text{AllowedOrderTypes} = [\text{MO}/\text{MLO}/\text{PMO}] \]

4.3. Definition of BestEx quote

The best execution quote of the Market Maker is given with the parameters of `BestQuote`.

The parameter `MaxSize` was used to define the maximum quantity of the stock which a Market Maker was able to provide for a best execution on trading day. The Parameter `PCID` defines the type of the product, for example security, currency, or futures whereas the parameter `RelativeLimit` defines the relative improvement of the price compared with the reference price. The set up is done for buy and sell side. Exemplarily, we only set the focus on the buy-side setting.

\[ \text{BidSide.ProductCategoryID} = [\text{PCID}] \]
\[ \text{BidSide.RelativeLimit} = \text{PriceImprovement} \]
\[ \text{BidSide.MaxSize} = [\text{Integer}] \]

4.4. Reference markets of Nasdaq Germany

In contrast to Xetra, in Nasdaq Germany a number of reference markets were used to determine the execution price. In MML, these markets are given within the `MarketNames-list` (c.f. Section 3.4).

5. MML Modelling of ICOM - A Trading System of the Commerzbank AG

ICOM (in the past WTS - Warrant Trading System) is an off-exchange trading system operated by Commerzbank AG for their private customers. Here, the bank is the only provider. The customer starts a query in form of a quote request, which is not binding, to ICOM. ICOM processes this quote request. This is done by computing the price for this quote request on the basis of finding the price based on an amelioration of the reference price. The reference price is derived from the own pricing model of the Commerzbank which is mainly based on current price on the Xetra and current market situations. Due to the price movements during trading hours, the customer is given only a prescribed time to accept or reject an offer.

Considering its structure, ICOM is a fixed price trading system and not a Best execution system which is defined above. It is a market model with additional parameters now defined in MML.

5.1. Definition of the ICOM Participants

The only provider is the bank, whilst the customers are the diverse registered private customers.

\[ \text{<MarketModel>} \]
\[ \text{<AllowedUsers>} \]
\[ \text{<Provider>providerId</Provider>} \]
\[ \text{<Customer>customerId</Customer>} \]
\[ \text{</AllowedUsers>} \]

5.2. Definition of the Quote Requests and the Price Offers

An order book does not exist in ICOM. Therefore, the quote requests of customers and the price offer of the bank have to be defined:

\[ \text{<QuoteRequest>} \]
\[ \text{<Product>productId</Product>} \]
\[ \text{<Size>n</Size>} \]
\[ \text{<Side>sell</Side>} \]
\[ \text{</QuoteRequest>} \]
\[ \text{<PriceOffer>} \]
\[ \text{<Product>productId</Product>} \]
\[ \text{<FixedPrice>execution cases</FixedPrice>} \]
\[ \text{<Side>buy</Side>} \]
\[ \text{<Size>n</Size>} \]
\[ \text{</PriceOffer>} \]

When the customers receive the price offer from the bank, they have the choice whether to accept or reject the offer. If they confirm the offer, they have a certain time to decide whether they are interested in buying or selling. This time is defined by \( \text{<ExecutionForFixedPrice>} \).

\[ \text{<ExecutionForFixedPrice>} \]
\[ \text{<TimeToAccept>time</TimeToAccept>} \]
\[ \text{</ExecutionForFixedPrice>} \]
\[ \text{</MarketModel>} \]

If the customers accept the offer during this period of time, the trade is initiated.

6. Conclusion

This paper presented the modelling and implementation of real world best execution systems by using MetaMarkets and market modelling language MML. First,
MML was presented as a market modelling tool and its theoretical fundamentals were discussed. It was shown that putting together an auction classification framework with the idea of generic transaction process based on the order life-cycle leads to elements of MML which can be used to configure auctions.

Based on the theoretical fundamentals, the modelling of best execution systems Xetra and Nasdaq Germany was demonstrated in Sections 3 and 4. Moreover, in Section 5, the parametrization of the exchange trading system ICOM was presented.

With MML, the modelling of different market models is improved. MML provides the market designer with more possibilities to design and construct complex market structures with additional services, making these markets more effective and attractive.

Our future work will focus on the evaluation and improvement of existing best execution systems using experiments and simulations in order to build more effective hybrid systems that accomplish that participants receive the price and liquidity that they expect.

References